FIBER OPTIC CABLE

FIELD OF THE INVENTION

The present invention relates generally to fiber optic cables and, more particularly, to fiber optic cables having at lest one water-swellable element.

BACKGROUND OF THE INVENTION

Fiber optic cables can be employed for the transmission of voice, video, and data in a variety of applications. Fiber optic cables can generally be classified into two categories, namely, trunk and distribution cables that have a large number of optical fibers and are designed to span relatively long distances, and drop cables that have a much smaller number of fibers and span much shorter distances and that typically terminate at a home or business. In order to protect the optical fibers across a relatively long span, trunk and distribution cables are generally relatively large and rigid cables. For example, trunk and distribution cables typically include a relatively thick jacket and a sizeable core to protect the optical fibers, and often include a protective metal armor jacket surrounding the core. In addition, the fiber-carrying passageways of trunk and distribution cables are frequently filled with a hydrophobic grease or gel that prevents migration of water through the passageways. As a result of their construction, trunk and distribution cables are generally relatively expensive.

In contrast to trunk and distribution cables, fiber optic drop cables are typically relatively flexible to facilitate the twisting and turning that the drop cable must undergo during most installations. Since fiber optic drop cables generally include fewer optical fibers and extend across shorter distances than trunk and distribution cables, fiber optic drop cables are also generally much smaller and much less expensive than trunk and distribution cables.

Fiber optic drop cables generally include a buffer tube that forms the internal passageway in which the optical fibers or other fiber optic elements are disposed. The buffer tube is typically extruded over the group of fiber optic elements, and then a protective outer jacket is extruded over the buffer tube.

Regardless of the type of fiber optic cable, a fiber optic cable is often designed to reduce, if not eliminate, the introduction of water into the fiber-carrying passageway of the cable and the migration of water therethrough. When water enters

the passageway, it can migrate lengthwise through the passageway until a closure or other termination device is reached. The water can then physically degrade the closure or other termination device and/or can damage electronics mounted within the closure or other termination device. In addition, if water that remains in the passageway should ever freeze, it can subject the optical fibers to undesirable forces.

To avoid such consequences, in some fiber optic cables the internal passageway is filled with a pressurized gas. The pressure of the gas within the cable passageway can be monitored and an alarm can be provided if the pressure drops below a threshold level that is indicative of a breach of the protective jacket of the fiber optic cable. In response to the alarm, the fiber optic cable can be repaired or replaced. While this type of system enables detection of a condition that can allow water infiltration, it does not prevent the water from entering and migrating through the cable and possibly damaging cable components before the cable can be repaired or replaced.

To limit the damage done by water infiltration, as noted above, some fiber optic cables have a hydrophobic grease or gel that fills the internal passageway or passageways in which the optical fibers reside. While the hydrophobic grease or gel blocks the migration of moisture through the passageways, the fiber optic cable must be designed and the hydrophobic grease or gel must be selected such that the hydrophobic grease or gel is compatible with the materials that form the other elements of the fiber optic cable with which the hydrophobic grease or gel is in contact. Since the fiber optic cable typically includes a buffer tube that defines the internal passageway that is filled with hydrophobic grease or gel, the buffer tube may have to be formed of a more expensive polymer than those that would otherwise be required in order to be sufficiently compatible with the hydrophobic grease or gel. In addition, fiber optic cables that include hydrophobic grease or gel are generally more difficult and less pleasant to handle during their manufacture, installation and repair.

Fiber optic cables have also been designed that include elements formed of water-swellable material. The water-swellable material is typically carried by yarns or tapes that are disposed within the passageway defined by the fiber optic cable. Upon contact with water, the water-swellable material will absorb the water and swell so as to physically close the passageway, thereby preventing migration of water

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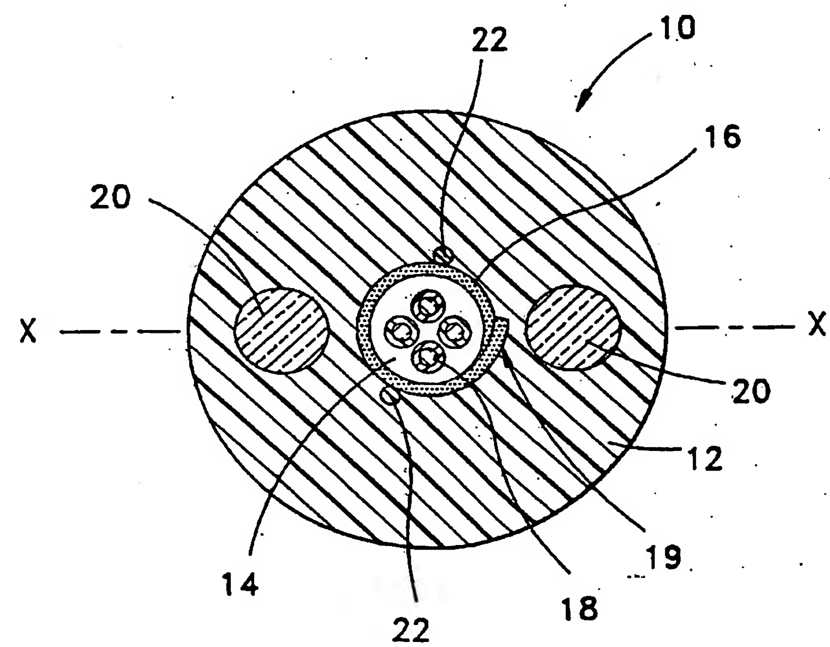

(57) Abstract: A low fiber-count fiber optic cable includes an outer tubular jacket, one or more optical fibers in loose, bundled, tight-buffered, or ribbon form disposed in the internal passageway of the jacket, a water-swellable element covering the inner surface of the jacket, and one or more strenght members embedded in the jacket. The water-swellable element is preferably formed of a water-swellable tape wrapped into a tubular configuration. The cable preferably includes two strength members on opposite sides of the fiber-carrying passageway such that the cable preferentially bends about a transverse axis that passes through the axes of the strength members.

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through the passageway. See, for example, U.S. Patent No. 5,684,904 to Bringuier et al. and U.S. Patent No. 5,039,197 to Rawlyk. Other cables include a layer of water-swellable material surrounding the buffer tube of the core, and the outer protective jacket of the cable surrounds the layer of water-swellable material. See, for example, U.S. Patent No. 5,157,752 to Greveling et al. The contents of the '904, '197, and '752 patents are expressly incorporated herein by reference.

While various fiber optic cables have been designed to prevent the introduction of water into and the migration of water through the internal passageways defined by the fiber optic cables, most of these fiber optic cables are relatively large cables that are best suited for use as trunk and distribution cables. For instance, the cable of the '197 patent has a solid plastic core having a star-shaped cross-section with six longitudinally extending grooves spaced about its outer surface. Each groove contains a buffer tube having six fibers therein, and each groove is filled with a hydrophobic grease or gel. A central strength member is embedded in the solid plastic core. The core with the buffer tubes is wrapped by a composite tape formed of a water-swellable layer bonded to a metal layer, and an outer polymer jacket surrounds the composite tape layer.

The cable of the '752 patent has six buffer tubes each containing 12 fibers. The inner surface of each buffer tube is covered by a water-swellable tape. The six buffer tubes are stranded about a central strength member and a metal sheath surrounds the buffer tubes and central strength member. An outer polymer jacket surrounds the metal sheath.

These types of cable constructions, because of their complexity and attendant high cost, are not practical in the case of low fiber-count cables suitable for use as drop cables.

SUMMARY OF THE INVENTION

In view of the foregoing, a fiber optic cable according to one aspect of the present invention includes an outer jacket having an inner surface and defining a longitudinally extending passageway therethrough; at least one fiber optic element disposed within the passageway of the jacket; a water-swellable element disposed between the inner surface of the jacket and the at least one fiber optic element such that the at least one fiber optic element is capable of contacting the water-swellable element; and at least one strength member embedded within the jacket. The at least one fiber optic element can comprise one or more optical fibers arranged in various manners including unbundled, bundled, tight-buffered, or ribbonized forms. Water-blocking members can be added to the fibers or can act as a binder in bundling fibers.

A fiber optic cable according to another aspect of the invention includes an outer jacket having an inner surface and defining a longitudinally extending passageway therethrough; at least one fiber optic element disposed within the passageway of the jacket; and a water-swellable element disposed between the inner surface of the jacket and the at least one fiber optic element such that the at least one fiber optic element is capable of contacting the water-swellable element; wherein the passageway in which the at least one fiber optic element is disposed is free of grease-like filling compounds.

According to yet another aspect of the invention, a fiber optic cable includes a tubular jacket having an outer surface with a diameter of about 5 to 30 mm and defining a longitudinally extending passageway therethrough; a water-swellable substance covering the inner surface of the jacket; at least one optical fiber disposed within the passageway; and at least one strength member embedded within the jacket; wherein a thickness of the jacket between the inner and outer surfaces thereof is such that at least 0.7 mm of jacket material covers the at least one strength member on radially inner and outer sides thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a cross-sectional view of a fiber optic cable according to one embodiment of the present invention.

Figure 2 is a cross-sectional view of a fiber optic cable according to another embodiment of the invention.

DETAILED DESCRIPTION OF THE INVENTION

The present invention now will be described more fully hereinafter with reference to the accompanying drawings, in which preferred embodiments of the invention are shown. This invention may, however, be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the invention to those skilled in the art. Like numbers refer to like elements throughout.

Referring now to Figure 1, a fiber optic cable **10** according to one preferred embodiment of the present invention is illustrated. Although fiber optic cable **10** can serve as a trunk and distribution cable, fiber optic cable **10** generally serves as a drop cable. Fiber optic cable **10** is therefore preferably designed to be relatively small. In this regard, fiber optic cable **10** preferably has a relatively small outer diameter such as between about 5 mm and 12 mm. In a preferred embodiment, for example, fiber optic cable **10** has an outer diameter of about 7 mm. In addition, fiber optic cable **10** is preferably designed to be relatively flexible to facilitate twisting and turning of fiber optic cable **10** during installation. The principles of the present invention, however, are not limited to small-diameter cables, and cables constructed in accordance with the invention can be made in much larger sizes, e.g., up to 30 mm in diameter or even larger. It should also be noted that although cable sizes are cited herein in terms of diameter because cables are frequently circular in shape, the invention is not necessarily limited to circular cables.

Fiber optic cable **10** includes an outer protective jacket **12**, preferably formed of polyethylene, such as medium density polyethylene, although PVC and other materials alternatively can be used. Jacket **12** defines a longitudinally extending passageway **14** therethrough. A water-swellable element **16** is disposed within passageway **14**, preferably covering the inner surface of jacket **12**. In addition, fiber optic cable **10** includes at least one and, more typically, a plurality of optical fibers **18** that extend lengthwise through passageway **14**. A typical optical fiber **18** includes a

silica-based core that is operative to transmit light, and a cladding that surrounds the core and has a lower index of refraction than the core. A soft primary coating surrounds the cladding, and a relatively rigid secondary coating surrounds the primary coating. Optical fibers 18 can be, for example, single-mode or multi-mode optical fibers made commercially available by Corning Incorporated. Optical fibers 18 can be disposed within passageway 14 in various manners, including unbundled, bundled, tight-buffered (900 μm), and/or ribbonized forms. Optical fibers 18 can also include a coloring layer to facilitate fiber identification.

Water-swellable element 16 can be provided in various forms including, for example, a coating of a water-swellable substance applied to the inner surface of jacket 12 and/or a coating of a water-swellable substance covering the outer surfaces of optical fibers 18. In a preferred embodiment of the invention, water-swellable element 16 comprises a water-swellable tape wrapped so as to form a tube interposed between the inner surface of jacket 12 and optical fibers 18. The water-swellable tape can be wrapped in various manners. Preferably, the tape is wrapped longitudinally such that a longitudinally extending overlap joint 19 is formed by overlapping opposite edges of the tape. Various types of water-swellable tapes can be used. A water-swellable tape typically includes a woven, nonwoven, or other fibrous or porous substrate having a water-swellable composition applied to one or both of the opposite surfaces of the tape. Suitable water-swellable compositions include super-absorbent polymers as described by U.S. Patent Nos. 5,039,197 and 5,684,904, the contents of which have been incorporated herein by reference. While various super-absorbent polymers can be employed in this embodiment, the super-absorbent polymers can be derived from sodium or potassium salts of acrylic acid, including commercially available super-absorbent polymers marketed under the trade names Cabloc 80 HS by Stockhausen, Inc. and Adall 1470 and 1460F from Chemdal Corporation. The water-swellable composition can also include anti-freezing components. One suitable water-swellable tape for the present purposes is a nonwoven waterblocking tape available from Lantor BV of The Netherlands.

Cable 10 also includes at least one and, more commonly, a number of strength members 20 embedded within the wall of protective jacket 12. To achieve adequate strength and yet have the ability to bend the cable, the preferred embodiment employs

two strength members **20**, or two groups of strength members each having plural closely spaced strength members, generally diametrically opposite from each other (Figure 1). This arrangement of strength members **20** enables cable **10** to preferentially bend about a transverse axis X-X that passes through the axes of strength members **20** as shown in Figure 1. Strength members **20** can be formed of various materials, including steel, glass, fiber-reinforced plastic materials such as glass-reinforced plastic (GRP) or aramid-reinforced plastic (ARP), liquid crystal polymer, and others. In the preferred embodiment of the invention, strength members **20** are formed of GRP. Although it is not essential, strength members **20** can be bonded to protective jacket **12** via a layer of adhesive therebetween. Various adhesives can be used for this purpose, including hot melts and other types of adhesives. For example, INSTANT-LOK hot melt available from National Starch and Chemical Company can be used for bonding strength members **20** to protective jacket **12**.

Cable **10** preferably also includes one or more ripcords **22** to enable protective jacket **12** to be opened to gain access to optical fibers **18**. Ripcords **22** in the embodiment of Figure 1 are disposed between water-swellable tube **16** and protective jacket **12**, but alternatively can be disposed within water-swellable tube **16**. Pulling a ripcord **22** both radially outwardly and in a longitudinal direction along cable **10** serves to sever or otherwise separate the cable coverings that lie radially outward of the ripcord so as to expose optical fibers **18**.

Fiber optic cable **10** most preferably comprises a tubeless design; in other words, cable **10** does not include any buffer tube surrounding optical fibers **18**. Accordingly, optical fibers **18** are capable of contacting the inner surface of water-swellable tube **16**.

In the event water should infiltrate into passageway **14** or otherwise come into contact with water-swellable tube **16**, the wall of water-swellable tube **16** will absorb the water and swell so as to form a blockage in passageway **14** preventing the water from migrating longitudinally along cable **10**. Fiber optic cable **10** can, if desired, incorporate such further water-blocking components as water-swellable yarns disposed in passageway **14**, and/or passageway **14** can be flooded with a filling compound such as a hydrophobic grease or gel. Preferably, however, passageway **14**

is free of such filling compounds. Where optical fibers **18** are bundled, water-swellable yarns can be used for binding optical fibers **18** together or can otherwise be incorporated into one or more fiber bundles.

Fiber optic cable **10** can be fabricated by various techniques. In the preferred embodiment of Figure 1 in which water-swellable tube **16** is formed by a water-swellable tape, the water-swellable tape and optical fiber or fibers **18** are drawn from respective pay-offs and are passed through a forming die that longitudinally wraps the water-swellable tape about optical fiber(s) **18**. As a result, the one or more optical fibers **18** are contained within water-swellable tube **16**. After the water-swellable tape has been formed into water-swellable tube **16** surrounding optical fiber(s) **18**, water-swellable tube **16** and optical fiber(s) **18** are passed along with ripcords **22** through an extruder that extrudes protective jacket **12** around water-swellable tube **16** and ripcords **22**. Protective jacket **12** can be bonded to water-swellable tube **16**, if desired, by applying an adhesive to the outer surface of water-swellable tube **12** prior to extruding protective jacket **12** thereover.

Strength members **20** are drawn from pay-offs and fed through the extruder tip into the stream of extrudate in the crosshead as jacket **12** is extruded between the tip and die, thereby embedding strength members **20** within the wall of protective jacket **12**. Strength members **20** can be coated with a suitable adhesive prior to being fed through the extruder die so as to bond strength members **20** to protective jacket **12**.

In embodiments of fiber optic cable **10** that include one or more water-swellable yarns, the yarns can be drawn from pay-offs in parallel with optical fibers **18** and the water-swellable tape, and the tape is wrapped about the yarns and optical fibers **18**. Furthermore, in embodiments in which ripcords **22** are disposed inside, rather than outside, water-swellable tube **16**, ripcords **22** are fed to the forming die in parallel with the other components of the cable core and are wrapped within the water-swellable tape. In each of these instances, the fabrication of fiber optic cable **10** is simplified relative to conventional fiber optic cable fabrication processes in that fiber optic cable **10** need not include any buffer tube.

Fiber optic cable **10** is particularly suitable for use as a drop cable. In this application, cable **10** preferably includes a relatively small number of optical fibers **18**, preferably no more than about 12 and, in some preferred embodiments, about one

to four. A preferred embodiment of a cable in accordance with the present invention has one to four optical fibers **18** with an outer diameter of protective jacket **12** of about 7 mm and an inner diameter of jacket **12** of about 3 mm. Water-swellable tube **16** is formed from a water-swellable tape about 11 mm in width, and is sized in diameter so that good contact is achieved between the inner surface of jacket **12** and the outer surface of water-swellable tube **16**. Passageway **14** within water-swellable tube **16** preferably is free of grease-type filling compounds for ease of manufacture, installation, and repair of cable **10**. Strength members **20** preferably comprise steel wires or GRP strands having a diameter of about 1.5 mm. Preferably, protective jacket **12** covers each strength member **20** such that at least about 0.7 mm thickness of jacket material covers each strength member **20** on both radially inner and outer sides thereof where the jacket material covering strength members **20** tends to be thinnest.

Figure 2 illustrates another embodiment of the invention. Fiber optic cable **30** shown in Figure 2 is generally similar in construction to cable **10** of Figure 1. Cable **30** includes a protective jacket **32** defining an internal passageway **34** therethrough. A water-swellable element **36** is disposed within passageway **34**, preferably covering the inner surface of jacket **32**. A stack **38** of optical ribbons is disposed in passageway **34** and extends longitudinally therein. Within the wall of protective jacket **32** are embedded a number of strength members **40**, in this case four metal wires arranged in two pairs of side-by-side wires. The two pairs of strength members **40** are located diametrically opposite from each other to enable preferential bending of cable **30** about axis X-X as shown in Figure 2. Two smaller-diameter strength members **40** are used on each side of the cable core rather than a single larger-diameter strength member on each side so that the requisite strength of the cable can be attained while maintaining adequate thickness of protective jacket material around all sides of strength members **40**. It will be understood, however, that the number and arrangement of strength members **40** can be varied within the scope of the present invention, the arrangements shown in the drawings being merely exemplary. Fiber optic cable **30** can be manufactured by a technique analogous to that described above for cable **10** and can include additional components such as water-swellable yarns and/or filling compounds if desired.

Water swellable elements **12, 32** of fiber optic cables **10, 30** effectively

prevent migration of water through internal passageways **14, 34** by swelling when exposed to water so as to form a blockage in the passageway. This prevents the water from reaching electronics or other water-sensitive components that typically are housed in a closure or other termination device to which fiber optic cable **10, 30** is connected. Preferably, fiber optic cables **10, 30** are free of buffer tubes such that the fabrication of the cables is simplified.

Many modifications and other embodiments of the invention within the scope of the appended claims will come to mind to one skilled in the art to which this invention pertains having the benefit of the teachings presented in the foregoing descriptions and the associated drawings. Therefore, it is to be understood that the invention is not to be limited to the specific embodiments disclosed and that modifications and other embodiments are intended to be included within the scope of the appended claims. Although specific terms are employed herein, they are used in a generic and descriptive sense only and not for purposes of limitation.

WHAT IS CLAIMED IS:

1. A fiber optic cable comprising:

an outer jacket having an inner surface and defining a longitudinally extending passageway therethrough;

at least one fiber optic element disposed within said passageway;

a water-swellable element disposed between the inner surface of the jacket and the at least one fiber optic element such that the at least one fiber optic element is capable of contacting the water-swellable element; and

at least one strength member embedded within the jacket.

2. The fiber optic cable of Claim 1, wherein the water-swellable element comprises a tape of water-swellable material wrapped into a tubular configuration.

3. The fiber optic cable of Claim 2, wherein the tape is longitudinally wrapped with opposite longitudinal edges of the tape overlapping each other.

4. The fiber optic cable of Claim 1, wherein the fiber optic element comprises one or more optical fibers disposed within the passageway.

5. The fiber optic cable of Claim 1, wherein the fiber optic element comprises a plurality of unbundled optical fibers loosely arranged in the passageway.

6. The fiber optic cable of Claim 1, wherein the fiber optic element comprises at least one optical ribbon.

7. The fiber optic cable of Claim 1, wherein the fiber optic element comprises at least one stack of optical ribbons.

8. The fiber optic cable of Claim 1, wherein the at least one strength member comprises a pair of longitudinally extending strength members embedded within the jacket on generally opposite sides of the passageway such that the cable preferentially bends about a transverse axis that passes through axes of the strength members.

9. The fiber optic cable of Claim 8, wherein the strength members comprise

one of fiber-reinforced plastic strands and metal wires.

10. The fiber optic cable of Claim 8, wherein the strength members are adhesively bonded to the jacket.

11. The fiber optic cable of Claim 8, wherein outer surfaces of the strength members directly contact the jacket without interposition of any bonding agent therebetween.

12. The fiber optic cable of Claim 1, wherein the passageway in which the at least one fiber optic element is disposed is free of grease-like filling compounds.

13. A fiber optic cable comprising:

an outer jacket having an inner surface and defining a longitudinally extending passageway therethrough;

at least one fiber optic element disposed within said passageway; and

a water-swellable element disposed between the inner surface of the jacket and the at least one fiber optic element such that the at least one fiber optic element is capable of contacting the water-swellable element;

wherein the passageway in which the at least one fiber optic element is disposed is free of filling compounds.

14. The fiber optic cable of Claim 13, wherein the jacket having an outer diameter of no more than about 7 mm.

15. The fiber optic cable of Claim 14, further comprising a pair of longitudinally extending strength members embedded within the jacket on generally opposite sides of the passageway such that the cable preferentially bends about a transverse axis that passes through axes of the strength members.

16. The fiber optic cable of Claim 13, wherein the cable has no more than four optical fibers within the passageway.

17. The fiber optic cable of Claim 13, wherein the water-swellable element comprises a water-swellable substance disposed along the inner surface of the jacket.

18. The fiber optic cable of Claim 17, wherein the water-swellable substance comprises a water-swellable tape formed as a tube covering the inner surface of the jacket.

19. A fiber optic cable comprising:

a jacket having an outer surface with a diameter of about 5 to about 30 mm and defining a longitudinally extending passageway therethrough, the jacket having an inner surface;

a water-swellable substance covering the inner surface of the jacket;

at least one optical fiber disposed within the passageway; and

at least one strength member embedded within the jacket;

wherein a thickness of the jacket between the inner and outer surfaces thereof is such that at least 0.7 mm of jacket material covers the at least one strength member on radially inner and outer sides thereof.

20. The fiber optic cable of Claim 19, wherein the jacket has an outer diameter of about 5 to 12 mm.

21. The fiber optic cable of Claim 20, wherein the at least one strength member comprises a pair of strength members each having a diameter of no more than about 1.5 mm.

22. The fiber optic cable of Claim 21, wherein the strength members are adhesively bonded to the jacket.

23. The fiber optic cable of Claim 21, wherein outer surfaces of the strength members directly contact the jacket without interposition of any adhesive therebetween.

24. The fiber optic cable of Claim 19, wherein the passageway in which the at least one fiber optic element is disposed is free of filling compounds.

25. The fiber optic cable of Claim 19, wherein the water-swellable substance comprises a water-swellable tape.

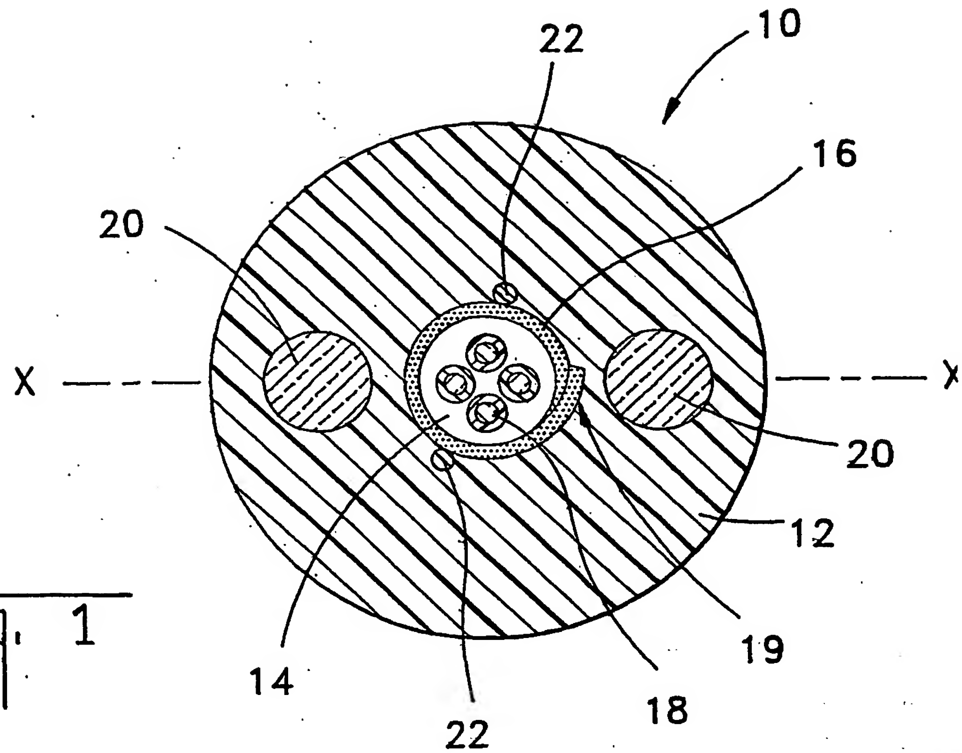

Fig. 1

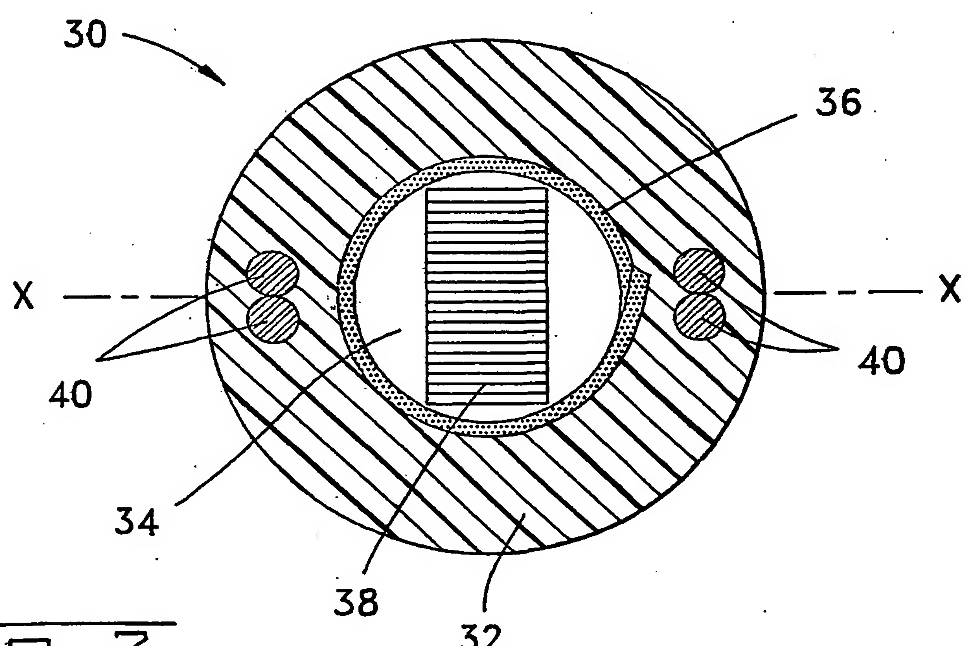

Fig. 2

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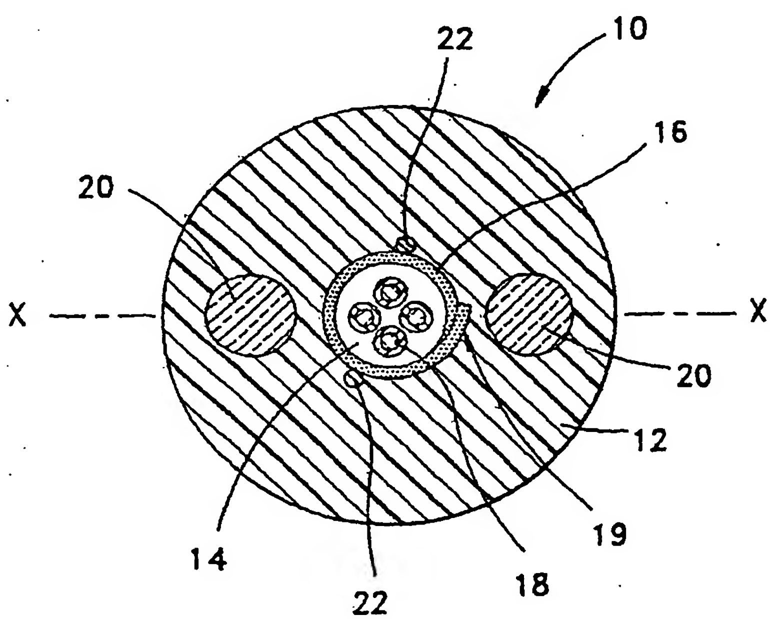
(54) Title: FIBER OPTIC CABLE



(57) Abstract: A low fiber-count fiber optic cable (10) includes an outer tubular jacket (12), one or more optical fibers (18) in loose, bundled, tight-buffered, or ribbon form disposed in the internal passageway of the jacket (12), a water-swellable element (16) covering the inner surface of the jacket (12), and one or more strenght members (20) embedded in the jacket (12). The water-swellable element (16) is preferably formed of a water-swellable tape wrapped into a tubular configuration. The cable (10) preferably includes two strength members (20) on opposite sides of the fiber-carrying passageway (14) such that the cable (10) preferentially bends about a transverse axis that passes through the axes of the strength members.

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(88) Date of publication of the international search report: 15 August 2002

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 01/40558

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G02B6/44

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 G02B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5 796 901 A (STAMMER MARC) 18 August 1998 (1998-08-18) column 2; claims 1-6; figures 6,7 ---	1,13,19
A	EP 0 373 846 A (AMERICAN TELEPHONE & TELEGRAPH) 20 June 1990 (1990-06-20) abstract; figures 1-4 ---	1,13,19
A	US 5 039 197 A (RAWLYK MICHAEL G) 13 August 1991 (1991-08-13) cited in the application abstract; figures 1-4 ---	1,13,19
A	US 5 157 752 A (GREVELING JOHANNES I ET AL) 20 October 1992 (1992-10-20) cited in the application abstract; figures 1,2 ---	1,13,19

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
7 February 2002	15/02/2002

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Malic, K

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 01/40558

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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